Integrated Lights-Out technology: Enhancing the manageability of HP ProLiant Servers

technology brief, 7th edition

Abstract

HP Integrated Lights-Out is an autonomous management subsystem residing on select HP ProLiant and BladeSystem server platforms. It provides system administrators with secure remote management capabilities, regardless of server status or location. This technology brief discusses the architecture of Integrated Lights-Out processors. It also describes key technologies that provide comprehensive remote management capabilities.

Additional papers about Integrated Lights-Out technology are available from the HP website at www.hp.com/servers/technology. The final section of this brief titled "For more information" includes references to specific Integrated Lights-Out web pages and other related material.

Introduction

The globalization of business and proliferation of industry-standard servers have made it impractical to administer servers locally. To meet increasing demands for IT efficiency and responsiveness, the need for remote management is critical, especially in corporate data centers. Integrated Lights-Out (iLO) technology provides hardware-based system management capabilities that enable IT administrators to control HP ProLiant and BladeSystem servers remotely.

Because iLO is integrated into the server platform, it can provide alerts, server status, power information, and remote control, regardless of the state of the operating system (OS) or the host server. Administrators can manage HP ProLiant and BladeSystem servers remotely through their entire life cycle (initial deployment, operation, and redeployment). Software and firmware can be updated over the network, and OS or server problems can be diagnosed remotely. The technology within iLO provides administrators with multiple options for accessing and managing their servers.

Naming conventions and capabilities

Integrated Lights-Out 2 (iLO 2) is the fourth generation in the HP product line for Lights-Out management and builds on the successful first-generation iLO management processor. In this technology brief, the iLO designation refers to the general technology or functionality available with both products: first-generation iLO and iLO 2. A designation of first-generation iLO or iLO 2 indicates that the functionality is exclusive to that product.

This brief discusses the capabilities supported in the iLO architecture. Some capabilities are supported by the iLO architecture but are only enabled with iLO Advanced for BladeSystem or iLO Advanced licensing keys. To determine which capabilities are supported in each of these licensing options, refer to the HP website www.hp.com/servers/ilo.

Integrated Lights-Out architecture

The iLO architecture consists of an independent firmware-based operating environment and a management processor. The management processor resides on the system board, using auxiliary power and operating independently of the host processor and the OS. This independence means that iLO has the following characteristics:

- Fully operational during a shut-down and reboot of the server because it does not depend on host server power
- Not dependent on the host processor for operation and does not use any processing cycles of the host processor
- Autonomous from the server hardware. Any problems occurring with the server hardware are isolated from the iLO processor
- Available for out-of-band management without assistance from the OS

Firmware levels and upgrades

The firmware can provide two levels of functionality—Standard and Advanced—depending on which level is enabled with licensing keys.

iLO Standard functionality includes basic system management functions such as the ability to power on and off the host server remotely, to access server status and diagnostics such as the Integrated Management Log, and to access system alerts such as SNMP traps. Because ProLiant BL servers are designed to be managed remotely, iLO Standard Blade Edition offers additional management and Lights-Out control features that are essential for headless environments. iLO Advanced for BladeSystem is designed for select environments such as HP BladeSystem or Linux® networks. iLO Advanced for BladeSystem supports more advanced capabilities such as virtual power control, virtual media, and other sophisticated security features. It activates the complete suite of remote management capabilities for ProLiant BL-based environments. The iLO Advanced Pack, on the other hand, provides the complete suite of remote management capabilities for ProLiant ML-, DL- and SL-based environments.

Because HP continually upgrades Lights-Out firmware with additional capabilities, and because server capabilities may differ, administrators should refer to the HP website at www.hp.com/servers/ilo for more information. Details are also available by logging in to the iLO or iLO 2 processor, navigating to the licensing page, and selecting the Help button.

Regardless of the iLO firmware level, administrators can upgrade the firmware by means of a flash ROM in the management processor. Refer to the iLO User Guide for the most current version of firmware. Features discussed in this brief require that firmware version as a baseline. The firmware can be updated in several ways, so administrators can select the method that best suits their data center environment. After administrators obtain the most recent firmware from the HP website, they can flash the ROM using one of the following resources:

- iLO web page
- Online ROM Flash Component from the operating system
- Bootable CD-ROM such as the firmware update CD
- Scripting tools such as RIBCL/HPONCFG/CPQLOCFG[1] over the network or from the host OS
- Command-line interface over telnet/SSH

Firmware updates are backward-compatible, meaning the latest firmware supports previous platforms with a compatible iLO processor; updates also include enhancements and bug fixes.

[1] See the HP Integrated Lights-Out Management Processor Scripting and Command Line Resource Guide, available at http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00294268/c00294268.pdf

Management processor overview

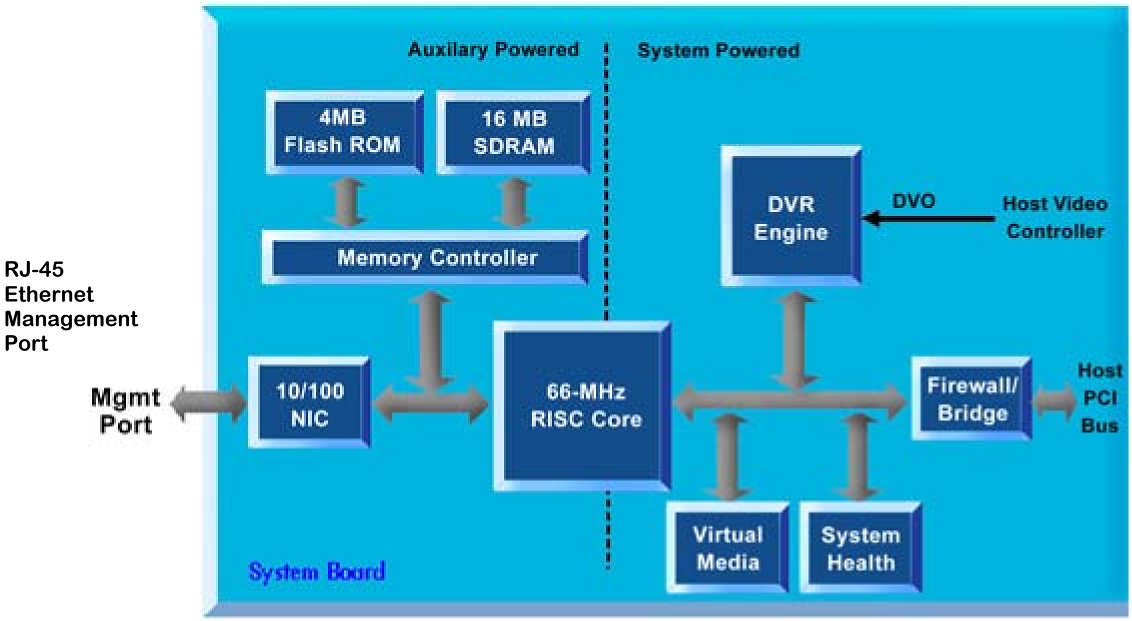
As indicated in Figure 1, the iLO 2 management processor includes the following chip architecture:

- 66-MHz RISC processor core with separate instruction set and integrated data cache
- Memory controller
- 4 megabytes (MB) of flash ROM
- 16 megabytes of memory (SDRAM)
- 24-MHz digital video redirection engine
- Dedicated 10/100 or at host NIC speed

Like the first-generation iLO processor, iLO 2 is a 32-bit, PCI-based processor. iLO 2 improvements include more memory and a new digital video redirection (DVR) engine. The aspects discussed in the following paragraphs apply to both first-generation iLO and the iLO 2 device.

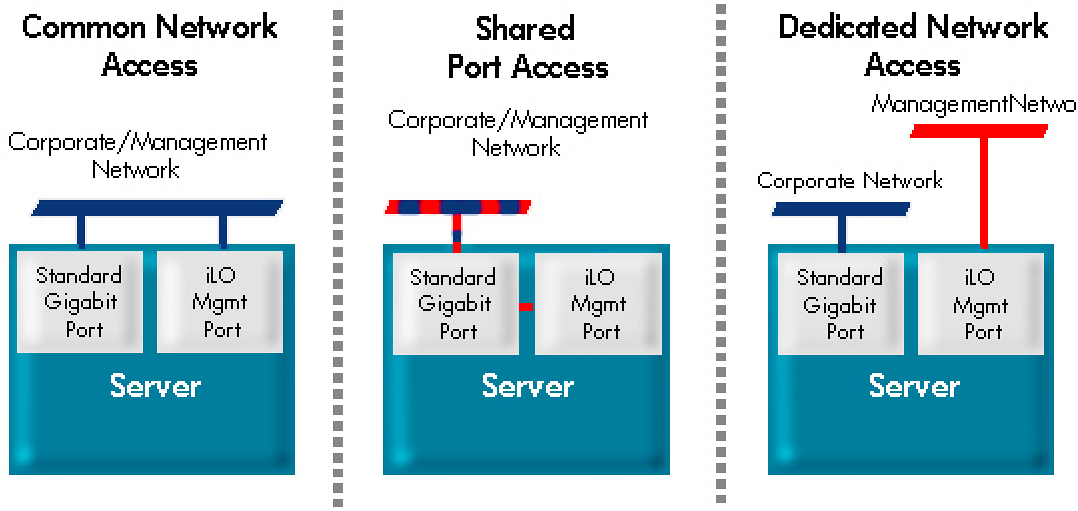
The NIC and associated RJ-45 management (Mgmt) port are independent of the 10/100/1000 Ethernet interface(s) provided by the host server.

Figure 1. This block diagram shows the configuration of the HP iLO 2 management processor. It is based on thel iLO processor, and adds enhancements including more memory and an updated digital video redirection.



Selected servers offer a Shared Network Port (SNP) that allows network access to both iLO and the host server through a single network port (see Figure 2), rather than dedicating a second port to the management processor. An SNP allows HP ProLiant servers to deliver optimal performance with fewer required ports, which can reduce recurring port use costs. With the SNP, iLO network traffic can be routed through a sideband connection on one of the NIC interfaces. Although the iLO traffic shares a port with the server OS traffic, both iLO and the server NIC have their own Media Access Control (MAC) address. Having separate MAC addresses lets iLO and the server have separate Internet Protocol (IP) addresses. For increased security and network consolidation, administrators can use optional virtual LAN (vLAN) tagging with manageable network switches to segregate iLO and host traffic, creating separate logical networks for host and management traffic. Using the SNP also simplifies hardware installation and reduces overall hardware costs because both corporate and iLO network traffic comes through the system NIC.

Figure 2. These diagrams illustrate three possible port configurations for system management traffic.



The iLO processor provides logic functions that monitor and control the host server. This logic implements Automatic Server Recovery-2 (ASR-2), which reboots the server automatically after recoverable faults and before imminent failures. Additional monitoring and control capabilities have expanded over time. For servers that support system-embedded health monitoring, the iLO 2 processor can monitor fans, power supplies, and temperatures. Server documentation for specific servers provides sensor and temperature information available through the Lights-Out processor.

The host firewall and bridge logic let the embedded processor control the flow of information between the host server and the management console. It protects against unauthorized access through the system PCI interface, and it shields sensitive information that may be stored in the memory or firmware. For additional information about host firewall and bridge logic, refer to the "HP Integrated Lights-Out security" technology brief at this URL: http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c00212796/c00212796.pdf.

Essentially, host power and fault isolation logic split the management processor into two separate areas: one operating under normal host system power; the other connected to the auxiliary power plane of the server. Even when the host server is powered down, the iLO processor will continue to operate, although the portions of iLO that communicate with the host processor are isolated. If the host server has redundant power supplies, power redundancy protects both the iLO processor and the host processor if a power supply fails.

Host power and fault isolation logic monitors the host system for any unexpected behavior such as a system power fault or PCI bus fault. The iLO management processor records power faults and operates normally on auxiliary power to provide key functions such as web browser access, alerting, and access to event logs. The host power and fault isolation logic allows either the management processor or the host processor to reset independently of the other. Server resets have no effect on the iLO processor; it provides administrators with continuous access to the server, which means that they can upgrade the iLO firmware without resetting or affecting the host server.

Integrated Lights-Out technologies

Through key iLO technologies such as remote console, virtual media, virtual power, and virtual serial port, system administrators can control iLO-managed servers efficiently from a remote location. Administrators can deploy new servers, install patches and hot-fixes, perform routine maintenance tasks, or troubleshoot platform issues from any remote location.

Remote Console technologies

Having full access to the host server using remote console technologies is one of the most important reasons to use an iLO processor. Remote console technologies provide system administrators with access to the managed server at any time, even before the OS is installed and if the OS is not functioning. For example, being able to see the host server console on the management client allows administrators to watch the entire boot process remotely.

Remote console technologies include a text-based console, a Java-based graphical console, and a Microsoft® ActiveX™-based graphical console. First-generation iLO and iLO 2 differ in the way that they capture text-based and graphical data; therefore, the following sections describe each method. Additional remote console technologies include screen capture and replay capabilities, a shared remote console, and Terminal Services integration.

Text-based remote console with first-generation iLO

The first-generation iLO processor supports a text-based remote console. iLO monitors the screen frame buffer through the PCI bus. When it detects changes in the text information, iLO captures, encrypts, and transmits the data—including screen positioning information—to text-based client applications. The advantages of this method are compatibility with standard text-based clients, good performance, and simplicity. Disadvantages include the inability to display non-ASCII or graphical information, and the possibility that screen positioning information (displayed characters) might be sent out-of-order.

System administrators can use the text-based remote console to view the managed server and interact with the Option ROM setup menus during POST. For ProLiant ML, DL, and SL servers, administrators must have a license key to access the remote console after the OS loads and goes into graphical mode.

Text-based remote console with iLO 2

The iLO 2 management processor has a DVR engine that uses the digital video output (DVO) port of the video adapter to directly access video output for high performance video monitoring. This method significantly increases iLO 2 graphical console performance. However, the available digital video stream represents graphical data (pixels); therefore, it does not provide a true text-based (ASCII characters) console. This video data cannot be rendered by a text-based application such as a telnet or Secure Shell (SSH) client.

The redirection of text during the server boot process is available as an iLO Standard feature on iLO 2 systems through the end of POST. Redirection of either text or graphics with iLO 2 after POST requires an iLO Advanced license for ProLiant ML, DL and SL-systems, but that functionality is included with the iLO Blade Standard package for ProLiant BL systems.

Administrators can access the iLO Virtual Serial Port using Remote Serial Console in the iLO 2 firmware. They can use the iLO Virtual Serial Port for text console access during POST and OS operation. The iLO processor contains hardware that can replace the physical serial port on the server's motherboard, and the iLO firmware provides a Java applet that connects to the server serial port. If the serial redirection feature is enabled on the host server, iLO intercepts the data coming from the serial port, encrypts it, and sends it to the Remote Serial Console applet or another application such as a telnet or SSH client. The iLO 2 Remote Serial Console applet appears as a text-based console, but the information is rendered using graphical video data.

Access to the iLO 2 Remote Serial Console is a standard feature and does not require a license key.

Virtual Serial Port/Remote Serial Console

Some operating systems, such as Microsoft® Windows® Server 2008 and Linux, provide text-based access to the server from the host server serial port. An administrator can connect a terminal to the serial port of the host server and perform basic management tasks. For example, if it is enabled, the Windows EMS Console displays the processes that are running and allows administrators to halt processes. This capability can be important in cases where video, device drivers, or other OS features have prevented normal operation and normal corrective actions.

An administrator can remotely access a console application, such as Windows EMS over the network using the iLO virtual serial port. As described in the previous section, the iLO management processor contains the functional equivalent of the standard serial port (16550 UART) register set, and the iLO firmware provides a Java applet that connects to the serial port. If the serial redirection feature is enabled on the host server,[2] iLO intercepts the data coming from the serial port, encrypts it, and sends it to the web browser applet or telnet application.

For Linux users, the iLO virtual serial port feature provides an important function for remote access to the Linux server. An administrator can configure a Linux login process attached to the serial port, and then use the iLO virtual serial port to remotely login to the Linux operating system over the management network.

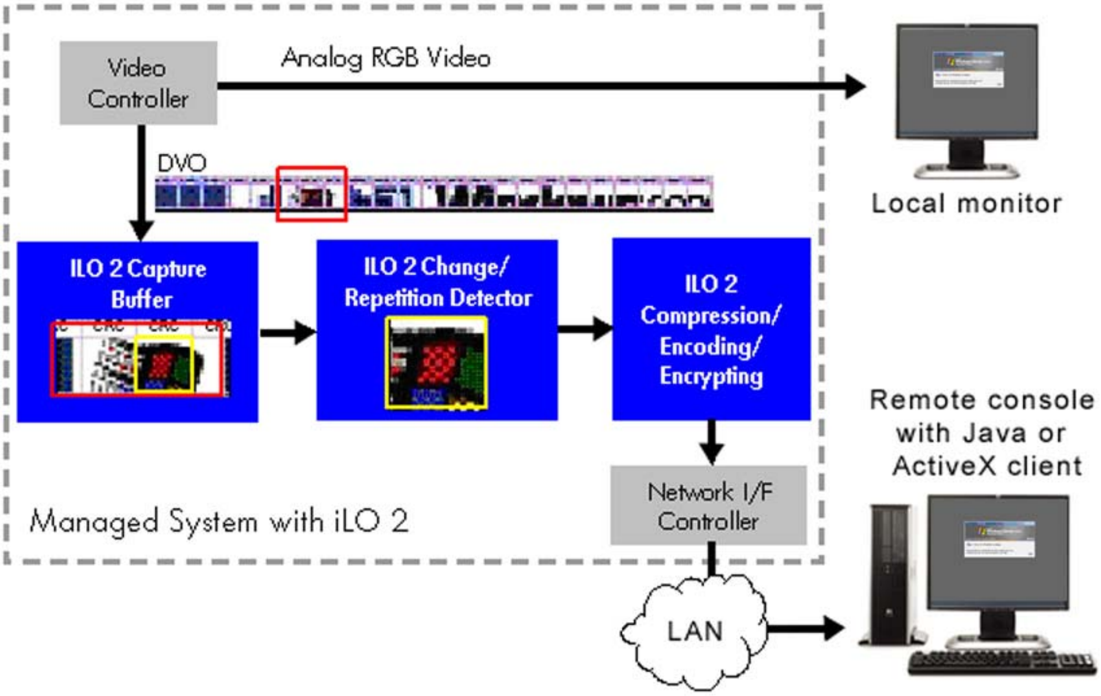
Additional details about using the Virtual Serial Port are available in the document titled "Integrated Lights-Out Virtual Serial Port configuration and operation." This is available at: http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00263709/c00263709.pdf

Digital Video Redirection (DVR) engine operation

The iLO first generation processor acquired management console video by monitoring the PCI bus for data sent to the video controller. In-band video monitoring is simple, cost effective, and adequate for emergency or part-time management console operation. As administrators began using iLO remote console for routine operations in addition to emergency management, improved video monitoring became necessary. The iLO 2 management processor uses a DVR engine for video capture. The DVR engine includes a video capture buffer (Figure 3) that monitors the Digital Video Output (DVO) of the host video controller (not the PCI bus). The DVR engine captures the screen image one stripe at a time.

[2] Linux users must also set up a login shell to the serial port (TTYS0) and configure the host server to allow root access.

Figure 3. This diagram represents an overview of how the iLO 2 digital video redirection (DVR) engine operates.


Video Controller
Analog RGB Video
Local monitor
DVO
ILO 2 Capture Buffer
ILO 2 Change/ Repetition Detector
ILO 2 Compression/ Encoding/ Encrypting
Remote console with Java or ActiveX client
Network I/F Controller
Managed System with iLO 2
LAN

An encoding process uses video characteristics such as changed/unchanged data and repetition/alternation for efficient video compression. Before it is sent over the network to the remote console, the video is encrypted and packetized. Either a Java or an ActiveX application on the client decodes and displays the data. With most of the video processing off-loaded from the management processor, overall performance substantially increases. Video refresh rates for the monitored video increase from a previous iLO average of 0.32 frames per second to over 6 frames per second. Operational bandwidth bottlenecks are reduced and the client system acts as the remote console.

Virtually all browser types support the Java-based remote console applet. HP refers to this functionality as Virtual KVM. Because of the high-performance DVR engine, administrators can rely on the iLO DVR for remote console operation. This reduces the need for KVM over IP solutions and the associated hardware.

Integrated Remote Console

The iLO 2 Integrated Remote Console combines the remote control capabilities of iLO—virtual KVM plus server power control and virtual media—into a single user interface. The Integrated Remote Console uses an ActiveX client application for the graphical remote console. The ActiveX client provides native operation in a Windows environment, as compared to the interpretive mode that the Virtual KVM application must run in a Java virtual machine. Thus, the Integrated Remote Console can provide better performance than the Java-based remote console. The DVR engine operation remains the same, regardless of which console an administrator uses. Additional iLO 2 capabilities, such as console capture/reply, shared remote console, and virtual folders, are also available through the Integrated Remote Console.

Console capture and replay

Using console capture, administrators can record and replay a video stream of events such as the last boot sequence, ASR-2 events, and OS faults. Administrators can manually start and stop the video capture so that any action an administrator takes using the remote console can be recorded.

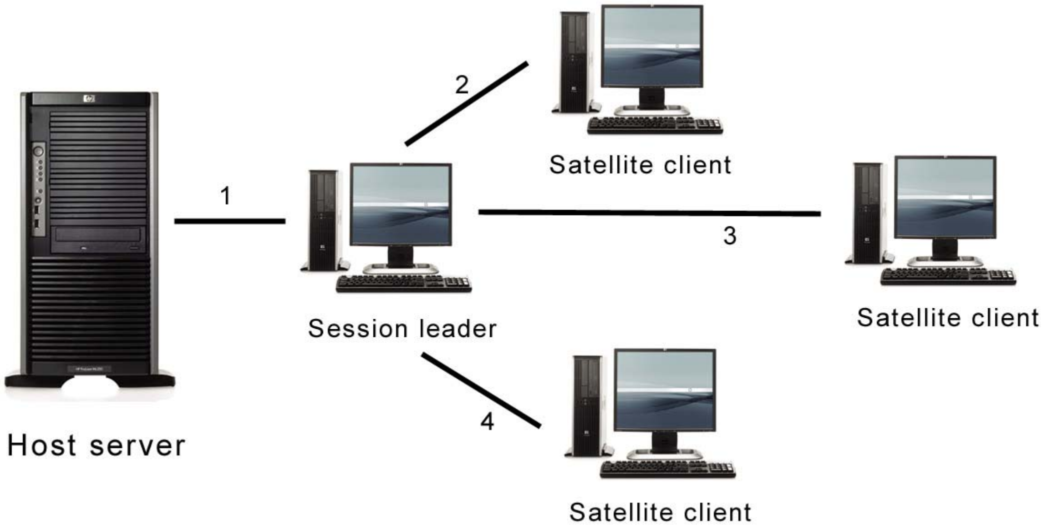
The iLO 2 processor stores captured video data in an internal buffer area for boot sequences and for ASR-2 and OS faults. With additional configuration, iLO 2 can export the captured data to an external file after the buffer fills. The external file is stored on a web server on the network. The iLO 2 processor continues to export captured files to the specified web server every time there is a reboot or an OS failure, as long as space is available. These files, each typically 2- to 3-MB, include a time stamp and an indicator of which type of data they contain. If administrators manually run the capture function, the data is stored on the client machine. Files created in this manner can be of any size.

Administrators can view the exported video capture files using the Integrated Remote Console application as well as a stand-alone tool for Windows called the HP iLO Video Player available for download from www.hp.com/support/ilo2.

Shared remote console

iLO 2 supports sharing a remote console session with up to four users, including the session leader. The administrator who initiates a remote console session connects to the host server normally and is designated the session leader. When another administrator tries to connect to the iLO 2 processor in a second remote console session, the iLO 2 processor transmits the IP address of the session leader computer back to the new client session. Thus, subsequent shared remote consoles become satellite clients in a peer-to-peer configuration, as illustrated in Figure 4.

Figure 4. This diagram represents a host server and a remote server console session. The first user in a shared remote console session becomes the session leader, while up to three others are satellite clients in a peer-to-peer configuration.



For each satellite client request, a pop-up window appears on the session leader's desktop, identifying the requester's user name and DNS name (if available) or IP address. All console sessions are encrypted through client authentication first, and then the session leader decides whether or not to allow the new connection to the remote console session. The session leader controls the remote console session. All satellite client sessions terminate when the session leader terminates the session. The shared remote console allows administrators at multiple locations to collaborate on troubleshooting or maintaining the remote server for greater IT efficiency and system availability.

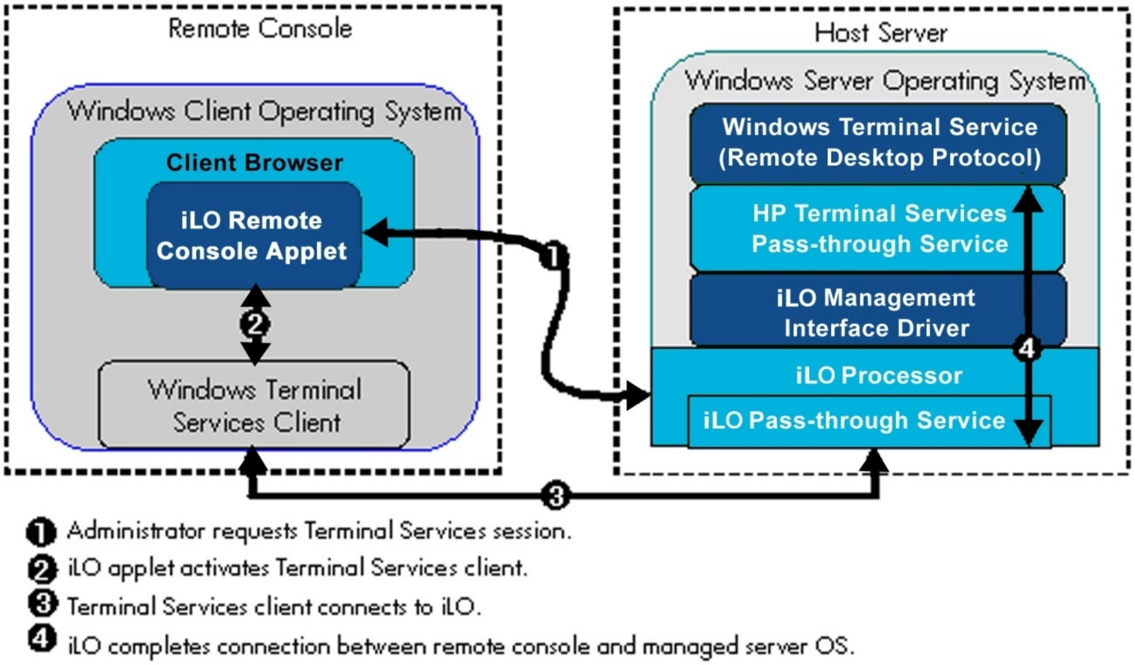
Terminal Services

The iLO processor can use the OS functionality of Windows Terminal Services[3] to increase the responsiveness of the graphical remote console. Terminal Services provide a software-based remote console as long as the host OS is functioning normally. If the host OS is not functioning normally, the iLO processor can revert to the iLO hardware-based remote console.

The iLO management processor accesses the Terminal Services application through the iLO pass-through service (Figure 5). When the administrator requests a Terminal Services connection, the iLO remote console applet activates the Terminal Services client application, which connects to iLO on the host server. The iLO device passes all the Terminal Services traffic to the managed server and completes the connection between the iLO browser and the Windows OS. The Remote Console client can connect directly through iLO without requiring an additional iLO login step.

Because Terminal Services is OS-based, it has the primitives that tell the OS how to open a window, the size and color of the window, and so on. Therefore, the Terminal Services application transmits only small amounts of information across the network, which can improve the graphical remote console performance.

Figure 5. This architectural diagram illustrates communication flow between the software–based remote console and the host server.


Remote Console
Windows Client Operating System
Client Browser
iLO Remote Console Applet
Windows Terminal Services Client
Host Server
Windows Server Operating System
Windows Terminal Service (Remote Desktop Protocol)
HP Terminal Services Pass-through Service
iLO Management Interface Driver
iLO Processor
iLO Pass-through Service
1
2
3
4
1 Administrator requests Terminal Services session.
2 iLO applet activates Terminal Services client.
3 Terminal Services client connects to iLO.
4 iLO completes connection between remote console and managed server OS.

Virtual media

The iLO processor provides virtual media by emulating USB devices to augment any existing storage peripherals in the host server. For example, the virtual media device can be a physical floppy, USB key, DVD or CD drive on the management workstation, or an image file stored on a local disk drive or network drive. Booting from an iLO virtual device allows administrators to upgrade the host system

[3] Terminal Services is available with Windows 2000 Server and later Windows operating systems.

ROM, upgrade device drivers, deploy an OS from network drives, create an emergency repair diskette, and perform disaster recovery of failed operating systems, among other tasks.

The iLO processor uses a client-server model to perform virtual media functions. It streams the virtual media data across a live network connection between the remote management console and the host server. The virtual media Java applet provides the data to iLO as it is requested.

The first-generation iLO management processor contains a USB device controller that the host OS views as a physical USB device plugged into the server. Under the control of iLO firmware, a virtual USB device can be remotely "inserted" into the host server. When the virtual media is inserted, the server OS activates the appropriate USB device support. Because iLO uses standard, built-in USB drivers, the iLO virtual media devices are available to host operating systems that support USB, without additional HP drivers running on the server.[4] Additionally, the system BIOS of the host server is extended to support USB virtual devices. Because of the BIOS extensions and the OS support, the iLO virtual media is always available.

The iLO 2 management processor builds on first-generation iLO by embedding a complete USB host controller. The host controller and iLO 2 firmware operate in a manner similar to iLO, but with improved support for the simultaneous use of multiple virtual media devices. The first-generation iLO USB device controller required USB composite devices to support multiple devices in use simultaneously. This method had a disadvantage: composite mode was not supported by all operating systems. The iLO 2 host controller makes it possible to use multiple devices simultaneously without using composite mode.

Virtual folders

Using virtual folder technology in iLO 2, administrators can copy files from client file systems to remote servers using simple "drag and drop" techniques. The iLO 2 virtual folder emulates a USB device, and creates a media image of the selected folder or directory. After creating a virtual image of the folder or directory, the server connects to the created image as a USB storage device, enabling administrators to browse to the server and transfer the files from the iLO 2-generated image to any location on the server.

The Virtual Folder feature is only available within the Integrated Remote Console. The virtual folder is compatible with FAT16 file systems (Windows and Linux), can contain a maximum of one gigabyte of data, is mounted as read-only, and is non-bootable.

Web-based or scriptable virtual media

Customers can store floppy, CD, and DVD image files on a web server and have iLO 2 access them over a web browser using HTTP/HTTPS protocols. Administrators can use an XML script or a command-line interface over telnet/SSH to send the URL of the image file to iLO 2.[5]

Using this method, the administrator does not need to open either the Virtual Media Java applet or the Integrated Remote Console Active-X control. If the client is connected across a wide-area network link to the target server, this technology provides virtual media with higher performance if the Virtual Media web server is located on a network segment close to the target server.

[4] Different operating systems provide varying levels of USB support which can affect iLO virtual media functions. For additional information, see the iLO User Guide at http://h18004.www1.hp.com/products/servers/management/ilo/documentation.html.

[5] See the HP Integrated Lights-Out Management Processor Scripting and Command Line Resource Guide available at http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00294268/c00294268.pdf.

Power Management Capabilities

Virtual power control

The iLO 2 processor allows administrators to power cycle a server remotely. Using a supported browser interface, a system administrator can use iLO 2 to remotely operate the power button of a host server as easily as pushing the physical power button. Virtual power support allows the user to power on, power off, and power cycle the server.

Like other aspects of iLO, the virtual power feature is independent of the OS and will work regardless of the state of the OS. However, iLO can take advantage of OS-supported power features. For example, with operating systems that are ACPI-compliant, such as Windows Server 2008, the momentary press of the virtual power button will initiate a graceful shutdown of the OS before turning off the power. An administrator can observe the shutdown process through the remote console window.

Some operating systems can establish power policies whereby the server can be shut down only through the OS or by pressing the power button for an extended time. The virtual power feature of iLO 2 allows the administrator to override such a host power policy and force a server shutdown if needed.

Managing server power

The main server processor complex is one of the single greatest power consumers in ProLiant servers. The iLO 2 processor can monitor CPU power states and can measure peak and average server power use, allowing administrators to monitor power and thermal requirements in remote servers.

HP ProLiant G6 servers have enhanced iLO 2 firmware that monitors and manages thermal parameters for a multitude of thermal sensors that monitor disk drives, fans, and DIMMs. This allows fan settings to be optimized for actual conditions rather than over-cooling the server.

HP Power Regulator

HP Power Regulator is an OS-independent power management capability of HP ProLiant servers that lets a system administrator control power use without significantly impacting server performance. In its default configuration, Power Regulator dynamically adjusts power consumption to match the workload of the server.

The Power Regulator firmware uses host processor performance registers to monitor processor utilization. The iLO 2 device collects the processor utilization data for each logical processor in the host server when the server is powered on and is not in POST. System administrators can configure Power Regulator settings to dynamically switch the processor from one performance state, or P-state, to another as processor utilization changes. Modifying the host processor P-state by reducing or increasing processor voltage and frequency as needed can result in significant power savings with minimal performance degradation.

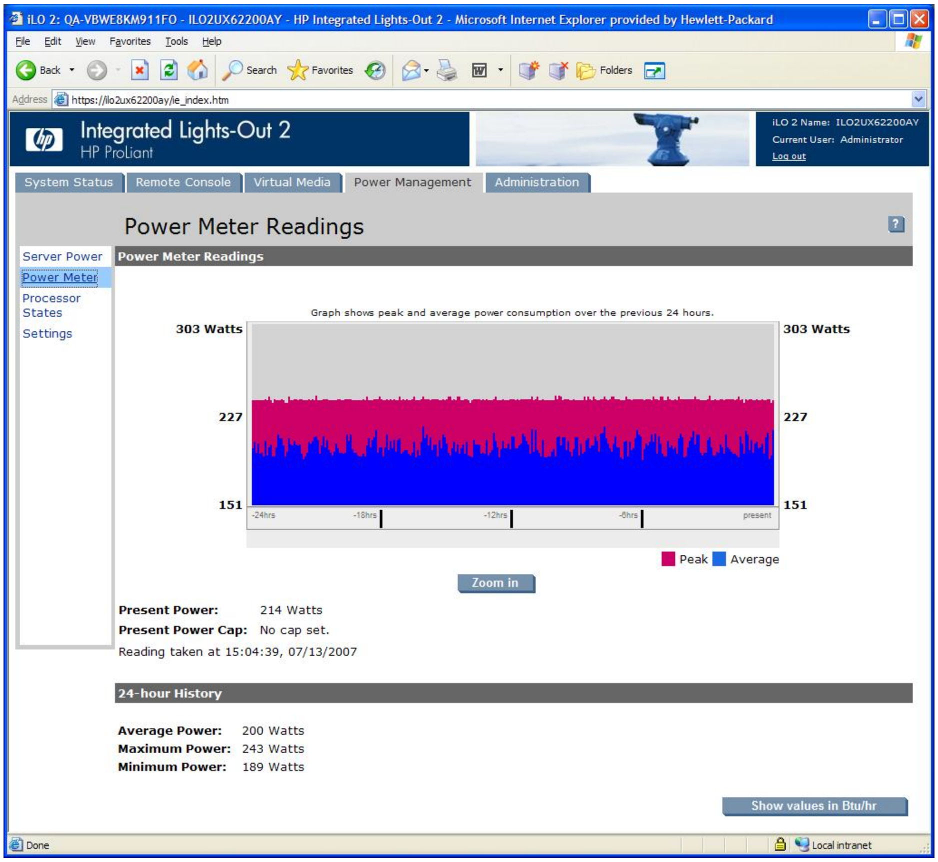
For more information about Power Regulator, see the technology brief white paper, “HP Power Regulator for ProLiant Servers.”[6]

[6] Available at http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00300430/c00300430.pdf

Power Meter

Being able to quantify how much power a server is actually using is the first step in managing power consumption at the server or facility level. Beginning with iLO 2 v 1.11, administrators can view actual system power consumption data in watts and Btu/hr. A snapshot of this historical data (Figure 6) is accessible from all iLO 2 interfaces. The data can be recorded and saved every 5 minutes. For example, a graphical display of power consumption can be retained up to 24 hours.

Figure 6. Power meter information can be retrieved from the iLO 2 processor from any web browser.



https://ilo2ux62200ay/ie_index.htm

iLO 2 Name: ILO2UX62200AY
Current User: Administrator

Power Meter Readings

Power Meter Readings

Graph shows peak and average power consumption over the previous 24 hours.

Present Power: 214 Watts
Present Power Cap: No cap set.
Reading taken at 15:04:39, 07/13/2007

24-hour History

Average Power: 200 Watts
Maximum Power: 243 Watts
Minimum Power: 189 Watts

HP Power Capping

Some ProLiant servers support basic HP Power Capping. HP Power Capping provides strict control of a server's maximum power consumption. iLO firmware adjusts server power performance to stay below the specified power cap. This allows an administrator to more effectively allocate data center cooling resources based on real server power consumption.

On servers that support basic Power Capping, the iLO 2 firmware monitors the power consumption of the server and checks it against a power cap set by the administrator. If necessary, iLO 2 adjusts the performance of the server to maintain an average power consumption that is less than or equal to the power cap goal.

Basic power capping requires the following system firmware:

- iLO 2 version 1.30 or later
- System BIOS 2007.05.01 or later

Administrators should refer to the ProLiant server user guide for additional information about power capping and to determine whether power capping is supported for their server.

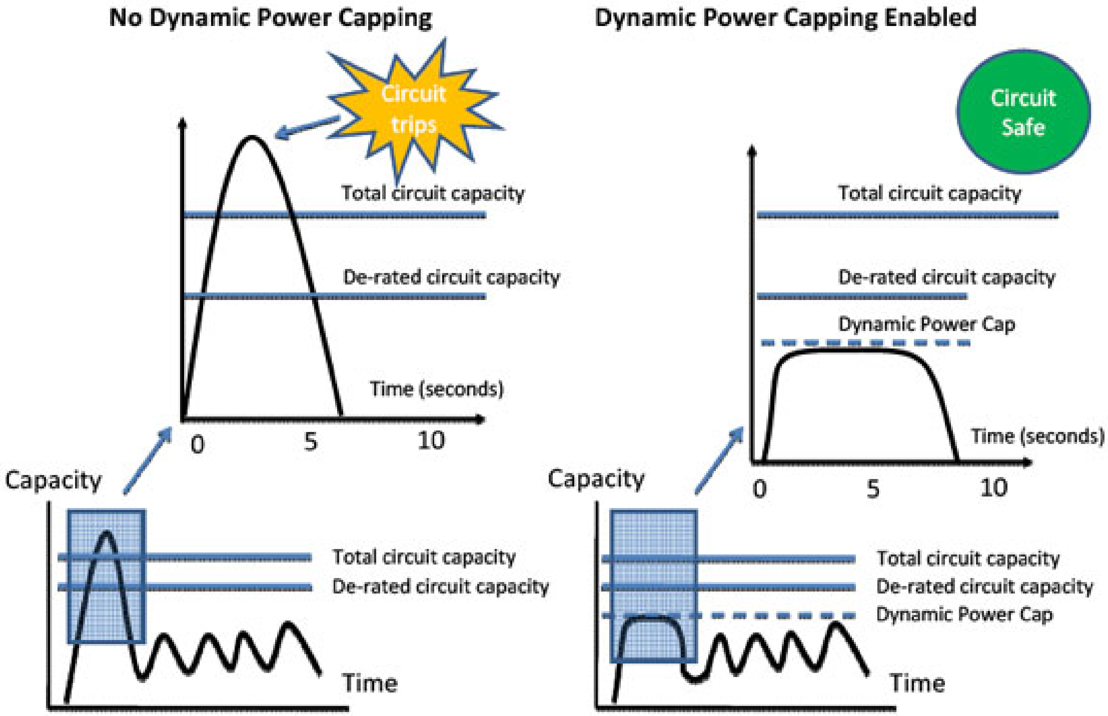
HP Dynamic Power Capping

Some ProLiant servers support HP Dynamic Power Capping. Dynamic Power Capping uses special hardware in the server to bring a server experiencing a sudden increase in workload back under its power cap in less than one-half second. This prevents any surge in power demand that could cause an enterprise-class circuit breaker to trip. Dynamic Power Capping has been designed and tested to ensure that it can prevent tripping circuit breakers that have a specified trip time of three seconds or longer at 50 degrees C and at a 150 percent overload.

To implement Dynamic Power Capping, the iLO 2 management processor works in conjunction with a power microcontroller to measure and control power consumption. When enforcing the Dynamic Power Cap, the power microcontroller keeps the processor's power consumption under a specified cap (see Figure 7). Administrators can set Dynamic Power Caps for individual servers from the iLO 2 user interface when using an iLO 2 Advanced Pack license. Dynamic Power Caps for multiple rack-mount servers can be set from the power management module within HP Insight Control Environment.

HP Dynamic Power Capping is operating-system independent and functions with all operating systems and software applications. It will continue to function even if the OS should fail.

Figure 7. A rapid response of Dynamic Power Capping can avoid circuit breaker trips.



Support for Dynamic Power Capping requires HP ProLiant hardware and the following system firmware:

- System BIOS 2008.11.01 or later
- iLO 2 version 1.70 or later
- Firmware version 3.4 or greater for HP ProLiant G5 and c-Class blades servers
- Firmware version 2.32 or greater for HP ProLiant G6 servers in ML and DL form factors
- Onboard Administrator firmware version 2.32 or later for HP BladeSystem enclosures

For more information on Dynamic Power Capping, refer to the support matrix at http://h18004.www1.hp.com/products/servers/management/dynamic-power-capping/support.html

Sensors and fan control

With the introduction of ProLiant G6 servers and iLO 2 firmware v 1.77, the sensor control functions of the south bridge I/O chip were expanded and moved into the iLO 2 firmware. Based on feedback from the applicable temperature sensor, the iLO 2 firmware uses a sophisticated algorithm to set and control the speed for each fan zone in the server chassis. Fan speeds change as the thermal conditions in the server chassis dictate. This allows fans to consume minimal power and maximize energy efficiency.

The iLO 2 v 1.77 firmware allows administrators to use multiple SMART sensors. ProLiant servers can have up to 64 sensors located on DIMMs, hard drives, and elsewhere throughout the server. The exact number of thermal sensors is dependent upon the server platform. Administrators can view the status of the temperature sensors through the iLO web pages and HP Systems Insight Manager.

iLO uses a sophisticated PID (proportional–integral–derivative) control feedback algorithm that allows much tighter control than previous multi-segment sensors. The PID algorithm takes into account the following elements:

- Proportional control. The algorithm output varies based on how high the temperature is compared to the target set-point (determined by thermal engineers during the HP design process).
- Integral control. The output varies based on the sum of the temperature changes over time. This is a function of how long the system takes to get closer to the target temperature set-point.
- Derivative control. The output varies based on the rate of temperature change over time. A greater rate of change in temperature results in increased fan speed.

Security

Because iLO enables remote server configuration and control, it is important to have strong security surrounding the iLO device. For example, the management processor includes built-in firewall functionality so that login credentials, passwords, and encryption keys stored in the embedded memory are secured from the view of any host software. The firewall is a hardware mechanism preventing any host software from accessing registers, data, and interfaces in iLO without passing the request through iLO firmware. This means malicious programs running on a compromised host cannot directly access the dedicated iLO network or data.

For detailed information about iLO security, refer to the “Integrated Lights-Out security” technology brief available at
http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00212796/c00212796.pdf

Because administrators generally use a network connection to access iLO, HP carefully considered security requirements of the enterprise and built iLO to provide secure ways to perform the following functions:

- Authorize and authenticate users
- Encrypt data transmitted over the network between the managed server and the management console
- Ensure data integrity by using digital signatures and digitally-signed firmware
- Alert administrators of potential login attacks

Authorization and authentication

Authentication refers to determining who is at the other end of the network connection. The iLO processor incorporates authentication techniques using 128-bit SSL (Secure Socket Layer) encryption and two-factor authentication techniques.

Authorization refers to determining whether the user attempting to perform a specific action has the right to perform that action. The iLO processor provides local user accounts to define up to 12 separate users and to vary each user's access rights to the iLO functions. Integration with Directory Services allows administrators to create more than 12 user accounts.

Two-factor authentication

Administrators can configure iLO to use two-factor authentication when accessing iLO through a browser. Two-factor authentication restricts access and ensures reliable user authentication by requiring a password or PIN and a private key for a digital certificate. Administrators can choose the type of device used to store the digital certificates and private keys, for example on a smart card or USB key.

Note
When iLO is configured to use two-factor authentication, administrators cannot use scripting or SSH communications.

Directory services

Administrators can use directory services to authenticate user access and authorize user privileges for groups of iLO management processors. Directory services use a central database called a *directory* to provide a consistent way to store information about objects such as servers, shared volumes, printers, network user accounts, and security policies. Maintaining this data in a directory makes it possible for all servers on the network to access the same user accounts, settings, and authentication services.

The integration feature of iLO directory services uses the standards-based Lightweight Directory Access Protocol (LDAP) to participate in the authentication and authorization processes of an existing user database. The iLO processor layers the LDAP protocol on top of SSL to transmit the directory services information securely to the directory.

HP provides snap-in management programs to ease directory-based administration of Lights-Out access rights. The snap-in management programs understand how to render, display, and manipulate Lights-Out objects stored in the directory. They integrate with existing management applications (Microsoft Management Console for Active Directory and Novell ConsoleOne for eDirectory) so that a separate administration application is unnecessary.

Using directory services simplifies user administration in multiple ways:

- Provides a single repository for all user accounts and Lights-Out devices. This allows IT managers to scale their infrastructure easily by managing all users' rights—including those for iLO management processors—in a single database.
- Uses the same security (password) policies as the rest of the network. Because directory services allow administrators to authenticate a user by means of the same login process employed throughout the rest of the network, corporate standards for security can be enforced easily.
- Supports thousands of users rather than only the few that an iLO and iLO2 processor supports without directory integration.
- Provides role-based administration with access and time restrictions, allowing administrators to more closely control access rights to iLO devices.

Data encryption

The first-generation iLO management processor uses SSL, RC4, and SSH protocols to ensure privacy of iLO actions, depending on the access modes and types of functions being performed:

- The iLO processor encrypts all HTTP web pages using 128-bit SSL encryption to ensure that all information and commands issued through the web browser are private.
- The iLO processor uses the RC4 streaming cipher algorithm to encrypt the remote console and virtual serial port sessions (if administrators enable the encryption).
- The CLP uses SSH to encrypt the data stream both to and from the host server.

The iLO 2 device provides additional security through two of the strongest available cipher strengths: the Advanced Encryption Standard (AES) and the Triple Data Encryption Standard (3DES). If configured to require maximum security, the iLO 2 processor enforces the use of AES/3DES over the browser, the SSH port, and the XML port.

SSL Certificate Import

The iLO processor generates self-signed SSL certificates as a standard feature. However, an administrator can replace the iLO SSL certificate by using CA-issued certificates based on an iLO certificate signing request.

Data integrity

The iLO processor ensures the legitimacy and integrity of any iLO firmware images by including a digital signature. A digital signature is generated using a private key, or encryption code, known only to HP. The iLO firmware verifies the digital signature by using a corresponding public key. The firmware contents cannot be modified without generating a new digital signature, which requires the original private key from HP. If iLO cannot verify the digital signature, iLO will not execute or even load the firmware. This safeguard prevents loading corrupt or rogue firmware.

The virtual media and remote console applets are also digitally signed. The digital signature ensures that when administrators view the applet window, the code originated from the iLO processor and it has not been altered or tampered with after the signature was applied.

After the digital signature has been accepted, the virtual media applet can read or write to the management console's physical floppy, CD drive, or the associated image files. Likewise, after the digital signature has been accepted, the remote console applet can automatically start the Microsoft Terminal Services client.

Event generation for failed login attempts

The iLO processor tracks all login attempts and maintains a record of all login failures. When login attempts fail, iLO generates alerts and can send them to a remote management console such as HP Systems Insight Manager. In addition, iLO adds progressive delays at each failed login attempt. After an initial failed login, iLO imposes a 5-second delay; after a second failed attempt, iLO imposes a 10-second delay; after the third failed attempt, iLO imposes a 60-second delay. This feature assists in defending against possible dictionary attacks against the browser login port.

Integration with other management tools

The iLO management processor is tightly integrated with other HP management tools and plug-ins such as HP SIM, ProLiant Essentials Rapid Deployment Pack, and ProLiant Essentials Insight Control Linux Edition. This integration allows administrators to gain easy access to iLO information and capabilities. In addition, iLO and other HP management tools incorporate standard management protocols and specifications to address customer requirements for security, interoperability among heterogeneous platforms, and ease of use.

HP Systems Insight Manager

HP Systems Insight Manager and the HP Insight Management agents are tightly integrated with iLO. This allows administrators to view subsystem and status information from a web browser. For example, the iLO 2 processor performs the monitoring for the server hardware (such as fan performance and internal board temperatures) and then forwards this information to the HP Insight Management agents. The information can be accessed either through HP SIM or through the iLO 2 web pages.

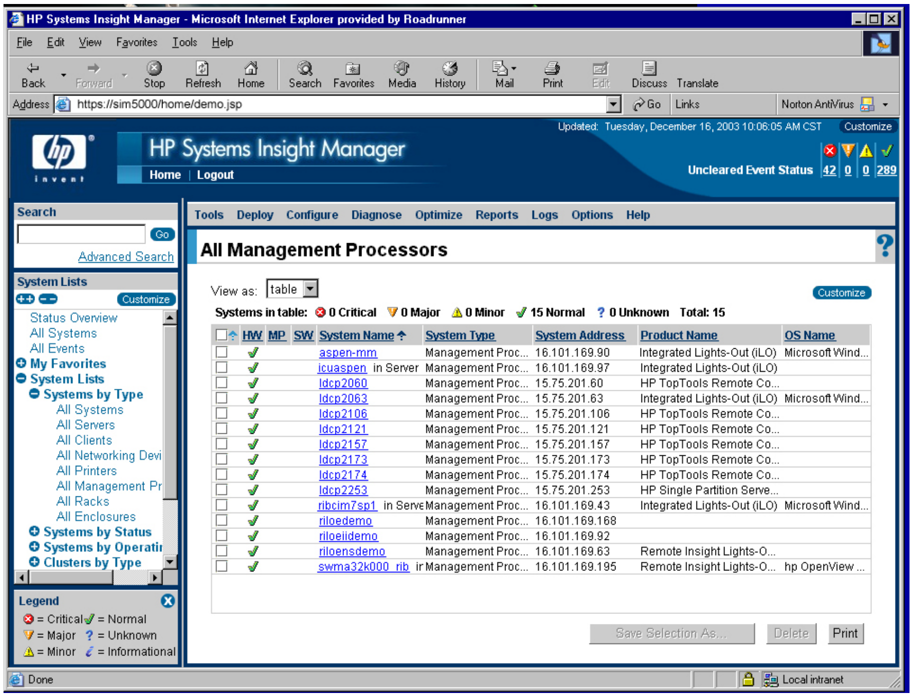
SNMP

The iLO processor can be configured to send iLO SNMP alerts to HP SIM or other SNMP-based management consoles. These iLO SNMP alerts include server events, such as a host server power outage or host server reset, and iLO events, such as unauthorized login attempts or a change to the Security Override Switch.

Discovery of management processors

Administrators can use the query mechanism of HP SIM to discover each iLO processor and store it on a device list. The device list provides direct hyperlink access to each iLO processor (Figure 8), giving the administrator a single location for accessing all Lights-Out management devices.

Figure 8. This diagram shows the HP iLO 2 device list accessible using HP Systems Insight Manager.


HP Systems Insight Manager - Microsoft Internet Explorer provided by Roadrunner
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites Media History Mail Print Edit Discuss Translate
Address https://sim5000/home/demo.jsp
Go Links Norton AntiVirus
Updated: Tuesday, December 16, 2003 10:06:05 AM CST
Customize
HP Systems Insight Manager
Home | Logout
Uncleared Event Status 42 0 0 289
Search
Go
Advanced Search
System Lists
Customize
Status Overview
All Systems
All Events
My Favorites
System Lists
Systems by Type
All Systems
All Servers
All Clients
All Networking Devi
All Printers
All Management Pr
All Racks
All Enclosures
Systems by Status
Systems by Operati
Clusters by Type
Legend
= Critical = Normal
= Major = Unknown
= Minor = Informational
Tools Deploy Configure Diagnose Optimize Reports Logs Options Help
Customize
Save Selection As... Delete Print
Done
Local intranet

All Management Processors

View as: table

Systems in table: 0 Critical 0 Major 0 Minor 15 Normal 0 Unknown Total: 15

☐	HW	MP	SW	System Name	System Type	System Address	Product Name	OS Name
☐	✓			aspen-mm	Management Proc...	16.101.169.90	Integrated Lights-Out (iLO)	Microsoft Wind...
☐	✓			icuaspen in Server	Management Proc...	16.101.169.97	Integrated Lights-Out (iLO)	
☐	✓			ldcp2060	Management Proc...	15.75.201.60	HP TopTools Remote Co...	
☐	✓			ldcp2063	Management Proc...	15.75.201.63	Integrated Lights-Out (iLO)	Microsoft Wind...
☐	✓			ldcp2106	Management Proc...	15.75.201.106	HP TopTools Remote Co...	
☐	✓			ldcp2121	Management Proc...	15.75.201.121	HP TopTools Remote Co...	
☐	✓			ldcp2157	Management Proc...	15.75.201.157	HP TopTools Remote Co...	
☐	✓			ldcp2173	Management Proc...	15.75.201.173	HP TopTools Remote Co...	
☐	✓			ldcp2174	Management Proc...	15.75.201.174	HP TopTools Remote Co...	
☐	✓			ldcp2253	Management Proc...	15.75.201.253	HP Single Partition Serve...	
☐	✓			ribcim7sp1 in Serve	Management Proc...	16.101.169.43	Integrated Lights-Out (iLO)	Microsoft Wind...
☐	✓			riloedemo	Management Proc...	16.101.169.168		
☐	✓			riloeiidemo	Management Proc...	16.101.169.92		
☐	✓			riloensdemo	Management Proc...	16.101.169.63	Remote Insight Lights-O...	
☐	✓			swma32k000_rib ir	Management Proc...	16.101.169.195	Remote Insight Lights-O...	hp OpenView ...

Power monitor

Using the Insight Power Manager plug-in, administrators can track overall power use from multiple servers and use this information to set power caps on groups of servers.

Single sign-on from HP SIM to iLO

HP SIM can provide single sign-on capabilities to iLO, allowing administrators to browse directly from HP SIM to iLO, bypassing an intermediate login step. Single-sign-on requires HP SIM v 5.1 or greater (with the HP SIM iLO 2 Single Sign-on Update), and requires configuring the iLO processor to accept the links from HP SIM.

Refer to the HP website, www.hp.com/go/hpsim, for more information about HP Systems Insight Manager. The HP SIM iLO 2 Single Sign-on update is available on the HP website at http://h18013.www1.hp.com/products/servers/management/hpsim/dl_windows.html?jumpid=reg_R1002_USEN#single.

Integration with deployment tools

Administrators commonly use different deployment tools, depending on what type of servers they are deploying:

- HP ProLiant Essentials Rapid Deployment Pack (RDP)[7] for Windows-based servers
- HP Insight Control Linux Edition[8] for Linux-based servers

Both these tools use the HP SmartStart Scripting Toolkit[9] and iLO capabilities so that administrators can configure iLO processors or use iLO capabilities to configure servers. Details about these tools are

[7] More information is available at www.hp.com/go/rdp.
[8] More information is available at www.hp.com/go/controltower.
[9] More information is available at www.hp.com/go/toolkit.

available in the more information section at the end of this document. For example, administrators can automatically power off servers, mount virtual CD images, and power on servers to deploy an OS to multiple servers. Or administrators can use these tools to browse to an iLO processor and access the iLO interface. This provides easy access to the iLO management features of HP ProLiant server systems.

Standards-based management

Technologies for server management continue to evolve and multiple server management specifications are contending for industry-standard status. To solve the customer's need for standardization, HP has contributed to the development of several specifications, and is strategically incorporating the industry-wide initiatives of Systems Management Architecture for Server Hardware (SMASH) and WS-Management into its management tools, including iLO processors and HP SIM.

With the SMASH Server Management Command Line Protocol (SM CLP), administrators can interrogate and control systems directly, such as reading the iLO system log to find server status or to indicate server health. Administrators can also use scripting with command-line protocols to directly manage a wide range of servers interactively.

WS-Management is emerging as the preferred programmatic interface for system management. Programmatic protocols, such as WS-Management, are machine-oriented and enable applications to manage the systems. For example, HP SIM uses WS-Management to interact with iLO management processors.

HP delivered the first implementation of SMASH-based technology with the first-generation iLO v1.70. As of this writing, administrators can use SM CLP to configure, update, and operate iLO features on HP ProLiant ML/DL 300 and 500 series servers, ProLiant SL products, and ProLiant BL server blades. HP is not planning WS-Management support for the first-generation iLO processor. WS-Management is one of the leading industry initiatives and is supported by iLO 2.

The iLO 2 v1.00 processor supports the draft SM CLP specification, and iLO 2 v1.30 adds WS-Management. This feature adds a new interface for accessing some of the information for the iLO 2 processor and sensors described by the Intelligent Management Platform Interface (IPMI) records. This allows HP SIM to access IPMI sensors through the WS-Management interface. The exact type and number of sensors depends on the server. Future firmware revisions are expected to broaden WS-Management support, thereby increasing iLO capabilities.

Accessing and configuring iLO

The iLO processor is designed to be flexible and reliable. Therefore, HP incorporated a variety of tools, such as a web browser or scripting tools, that administrators can use to access the iLO processor. Administrators also have multiple options for configuring the iLO and iLO 2 processors.

Methods to access iLO

Because each data center or remote site may have different access requirements, HP designed the iLO processor with multiple options for accessibility: web-based or text-based. Administrators have web-based access to the iLO management console through a standard browser such as Microsoft Internet Explorer or Mozilla Firefox.[10] The iLO web interface groups similar tasks together and organizes them under high-level tabs such as System Status, Remote Console, Virtual Media, Power Management, and Administration.

[10] Refer to the iLO user guide for information about supported browser versions.

Administrators who want to use text-based controls can access the iLO and iLO2 processors using SSH or telnet. If the OS supports it, they can also use the virtual serial port infrastructure, as described in the section "Virtual Serial Port/Remote Serial Console." The text-based interface allows administrators to use the SMASH SM CLP to configure or update iLO and execute iLO processes.

Configuring iLO

Administrators can configure individual iLO management processors in any of the following ways:

- Browser-based web interface
- Local iLO ROM-based setup utility (RBSU) when the system environment does not use DHCP, DNS, or WINS
- Text-based commands to the SMASH CLP through telnet, SSH, or the serial port
- Scripted configuration using Lights-Out configuration utilities and RIBCL/XML or Perl scripts

Scripting is commonly used for configuring multiple iLO processors (for example, configuring network settings, user accounts, or updating firmware). Administrators can also use scripts to deploy a standard configuration onto a single server, for extracting information such as event logs or BIOS records, or for automated deployments. The same script can be used from within the host OS (on-line) as well as over the network (remotely). Using the RIBCL/XML or Perl scripting tools allows administrators to script Lights-Out operations during deployment, during server operation, and remotely.

For example, using the CPQLOCFG utility, an administrator might write a script to remotely upgrade the system BIOS for every server in a rack. The script might instruct the iLO device in each server to do the following: power down the server, download the new BIOS, and then power up the server. With XML-based remote scripting capabilities, every function or task an administrator can do using Lights-Out technology and a web browser can also be done in a secure environment through an XML script running at a remote site.

More information about configuring iLO processors is available in the "Planning and configuration recommendations for Integrated Lights-Out processors" technology brief.[11] The HP Integrated Lights-Out Management Processor Scripting and Command Line Resource Guide contains additional information about scripting. Sample scripts files are available from the website at http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00294268/c00294268.pdf

Conclusion

Integrated Lights-Out technology provides system administrators a robust, secure, independently operated connection to the managed server, regardless of the state of the server. The iLO management processor is designed for scalability: Using directory services or scripting tools, administrators can easily deploy and manage tens or hundreds of iLO processors. Integrated Lights-Out functionality improves system administration efficiency so that IT groups can operate more productively.

[11] Available at http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00257375/c00257375.pdf

For more information

Visit the following links to learn more about Integrated Lights-Out and related remote management technologies.

Resource description	Web address
Integrated Lights-Out home page	www.hp.com/go/ilo
iLO support and downloads	www.hp.com/support/ilo www.hp.com/support/ilo2
Industry-standard servers technology papers	www.hp.com/servers/technology
HP Integrated Lights-Out security	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00212796/c00212796.pdf
Documentation for iLO and iLO 2	http://h18004.www1.hp.com/products/servers/management/iLO 2/documentation.html
Directory support for Lights-Out processors	http://h18004.www1.hp.com/products/servers/management/directorysupp/index.html
Software and drivers for Lights-Out processors	http://h18007.www1.hp.com/support/files/lights-out/us/index.html
Lights-Out supported servers	www.hp.com/servers/ilo/supportedservers
Information about iLO 2 Advanced licenses	www.hp.com/servers/iloadv2
HP Insight Power Manager	www.hp.com/products/ipm
ProLiant Essentials Rapid Deployment Pack	www.hp.com/go/rdp
HP Systems Insight Manager	www.hp.com/go/hpsim
HP Insight Control Linux Edition for HP BladeSystem	www.hp.com/go/controltower
SmartStart Scripting toolkit	www.hp.com/go/toolkit
Integrated Lights-Out Support page	www.hp.com/support/ilo
Integrated Lights-Out 2 Support page	www.hp.com/support/ilo2

Call to action

Send comments about this paper to TechCom@HP.com.

TC090906TB, September 2009